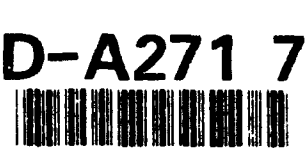

(2)

AT&T Bell Laboratories

Subject: AT&T OETC quarterly technical report for July-Sept 1993[1]

Date: Oct 10, 1993
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Enclosed please find copies of the Quarterly *R&D* Status and Technical Reports for ARPA Contract MDA972-92-C-0074 covering the period of July 1 through Sept 30, 1993.

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Summary of AT&T Quarterly Report July-Sept, 93

Task A.1: VCSEL fabrication

New mask used for reducing the metal traces and increasing chip speed is completed, and used on the first wafer. This wafer, which also has full wafer SiO_2 window passivation, has low Ith (~ 4 mA), moderate resistance (V(@11 mA) ~ 3.8 V), and good power (Lmax = 1.65 mW).

Preliminary (manual) array testing for wafer# 1378 (multimode) shows good array and acceptable wafer array uniformity for Ith (standard deviation = σ ~ 5%), Vth (σ < 4%), λth (σ < 3 nm), and Vop(@11mA) (σ ~ 1.5%) for 5 arrays sampled across the wafer and 5 sites (+ Right and Left monitor lasers) per array. L(@11mA) has more variation (σ ~ 4 to 20%) due to its multimode nature.

Automated full wafer array test set is fully functional. Full array testing for five sampled sites of wafer# 1378 were completed. **Figure 1** shows I_{th} at room temperature, 70 C, and 100 C. Full wafer array test is ongoing.

To meet the first deliverable and without dicing wafer# 1378 before completion of the full wafer array test, five VCSEL arrays from wafer# 1374 (which has the same design and processed at the same time as wafer# 1378, therefore should have the same device characteristic except with 100 μm wide metal runner) were identified and will be packaged in the first few TX module to be delivered in Nov ARPA and User Group meeting.

Due to reorganization in AT&T Bell Labs., GaAs *process* technology for the VCSEL will be transferred to Murray Hill , N.J. facility from the Breinigsville, PA facility. Wafers are still grown in Breinigsville, and 4 wafers were grown to facilitate process transfer to Murray Hill. Process transfer to Murray Hill was completed at the end of Sept.

Milestones 9 (Laser Redesign) , 10 (Laser production), and 11(this quarterly report) of Task A.1 completed.

1.2 Task A.2: Transmitter packaging

Designs of SEL array driver IC and monitoring op amp circuits were obtained from Martin Marietta during the 8/3 package review in Murray Hill. Preliminary layout for the Film Integrated Circuit (FIC) was initiated. Updated information on laser driver op amp chips and full schematics of the Tx module were received on 8/30. Delayed confirmation of final circuit design from Martin Marietta causes the final layout for the transmitter multichip module to be sent to MM on 9/24/93 for final approval.

Optical crosstalk measurement of light coupled into angle polished fiber indicates negligible crosstalk of - 48 dB (< -30 dB, the link spec.).

Self-alignment soldering has been demonstrated in mechanical quartz-Si pair to an accuracy of ~ 2 μm which is more than sufficient for the laser to multimode fiber coupling requirement. This process will not be used in the first delivery. However, alignment using pre-designed alignment marks will ensure sufficient alignment accuracy.

Gold adhesion process using a special chemical treatment for mirrors on 45 degree polished fiber ends on fiber array block (FAB) has been demonstrated using Scotch tape test. This process will be used in the fabrication of all of our FABs for this program.

A new mask for Si base plates to accommodate *both* the SEL chip and the IBM receiver chip (epoxy bonding) has been generated and made.

We have more experience in assembling FAB and have improved some of the fixturing. Much effort was put into process/yield improvement: elimination of occasional fiber delamination during polishing; cleaner polyimide stripping of fiber ribbon; better fixturing to avoid chipping of fiber array blocks (FABs) during the adhesion treatment and gold mirror evaporation process. Work continued on improving the FAB polishing process including damage prevention, and a method for polishing multiple (now 5) FABs at a time. These improvements should result in significant cost reductions for the manufacture of this part. More FABs have been manufactured and mirrors gold coated. (As of 8/31, had 5 good gold mirror FABs, and as of 9/13, have > 20 waiting for gold).

14 sets (spacer, clips, and vertical spring) of ODL connector parts were made and will be used mechanically to hold the fiber connector piece to the Tx and Rx module.

Milestone 8 (Status Report on Test Assembly), 9 (Packaged Laser Array Ver. 2), and 10 (Deliver Prototype Models) of Task A.2 are delayed due to unavailable laser chip IC driver from Martin Marietta, and will be completed in the Nov delivery.

1.3 Task A.3: Receiver packaging

Silicon base plate for the receiver OSA have been designed and the first models produced. The fiber array block will be the same as that used for the transmitter.

Mask layout of FIC completed. IBM approved the mask layout. Masks were made and MCM-C substrate will be available on Oct 12, 93.

Array wire bonding of 70/6 μm of line/spacing from pads on ceramic to full Au metal is demonstrated. This is the wire bond dimension required to take the data signals off the receiver chip.

7 mechanical (detector array only without circuit) chips and 7 partially functional MSM detector chips were received from IBM. Six chips have been bonded to silicon baseplates, and the baseplates to aluminum models of the heat spreader. These assemblies were

delivered to Merrimack Valley, Mass. Bell Labs facility, for further assembly with the MCM-C module.

1.4 Task A.4: Fiber connector

The last 16 cables have been fabricated on Sept 23, 1993. The average loss of the 32 MAC connectors was 0.48 dB with maximum fiber loss of 1.16 dB.

All milestones (1-6) of Task A.4 were thus completed.

1.5 Task A.5: Project management

A package review meeting was held on Aug 3, 1993 in Murray Hill, Bell Lab. Preliminary layout of receiver module was reviewed with IBM. Final layout was approved later through fax, mail and phone conversations. Circuit schematics of the transmitter module was shown by Martin Marietta with inclusion of 2 op amps for the feedback monitoring photo diodes. Final layout was sent to MM for approval at the end of Sept, expected to be approved in 5 working days.

All necessary piece parts and their availability were tracked very closely because of the tightness of the schedule for the first delivery at the Nov ARPA and User Group meeting. Details of the complete assembly process flow charts for TX and RX were revisited to avoid misunderstanding of who is responsible for what. Many discussions were held between MM, IBM, and AT&T on the TX and RX packaging schedules since all organizations wanted to conduct more wafer characterization (known good die issue) prior to wafer dicing.

At Martin Marietta's request, MAC cable with fanout connector, locations of pin I/O of the module lead frame were sent to Martin Marietta to facilitate the making of high speed testing fixture and testing.

Professor Larry Coldren and his student visited Murray Hill on Sept 20, 1993 for technical discussion of some bit rate measurements. However, some setup stability and equipment problem surfaced that prevent them to measure the VCSEL at 1 Gbps.

2. Anticipated Activities for Oct-Dec 93

2.1 Task A.1: VCSEL fabrication

Standard OETC wafer (625 μm thick, double side polished, with 20 μm metal trace) will be grown in STC, and fully processed in MH. Results will be compared with previously wafer such as wafer# 1378 for reproducibility and device characteristic uniformity. Full wafer and array testing will be completed for wafers fabricated in STC.

2.2 Task A.2: Transmitter packaging

Final MCM-C layout will be approved by Martin Marietta, masks will be ordered, and MCM-C substrate will be available on Nov 4, 93. Both mechanical and good (10 each) laser driver chips will be received from Martin Marietta during Oct 11-15, 93. Corresponding OSA will be assembled. *Hopefully*, a transmitter module will be completely assembled before Nov 18 meeting.

2.3 Task A.3: Receiver packaging

MCM-C substrate will be available on Oct 12, 93. Fully functional MSM detector array chips will be received from IBM during 11-15 of Oct. Five set of heat spreader, Si base plate, detector array chip, and fiber array block will be delivered to Merrimack Valley for full receiver module assembly (lead frame attachment, decoupling capacitor attachment, fine pitch wire bonding). Three modules will be delivered to Martin Marietta for high speed link testing before Nov meeting.

TEMP.XLS Chart 3

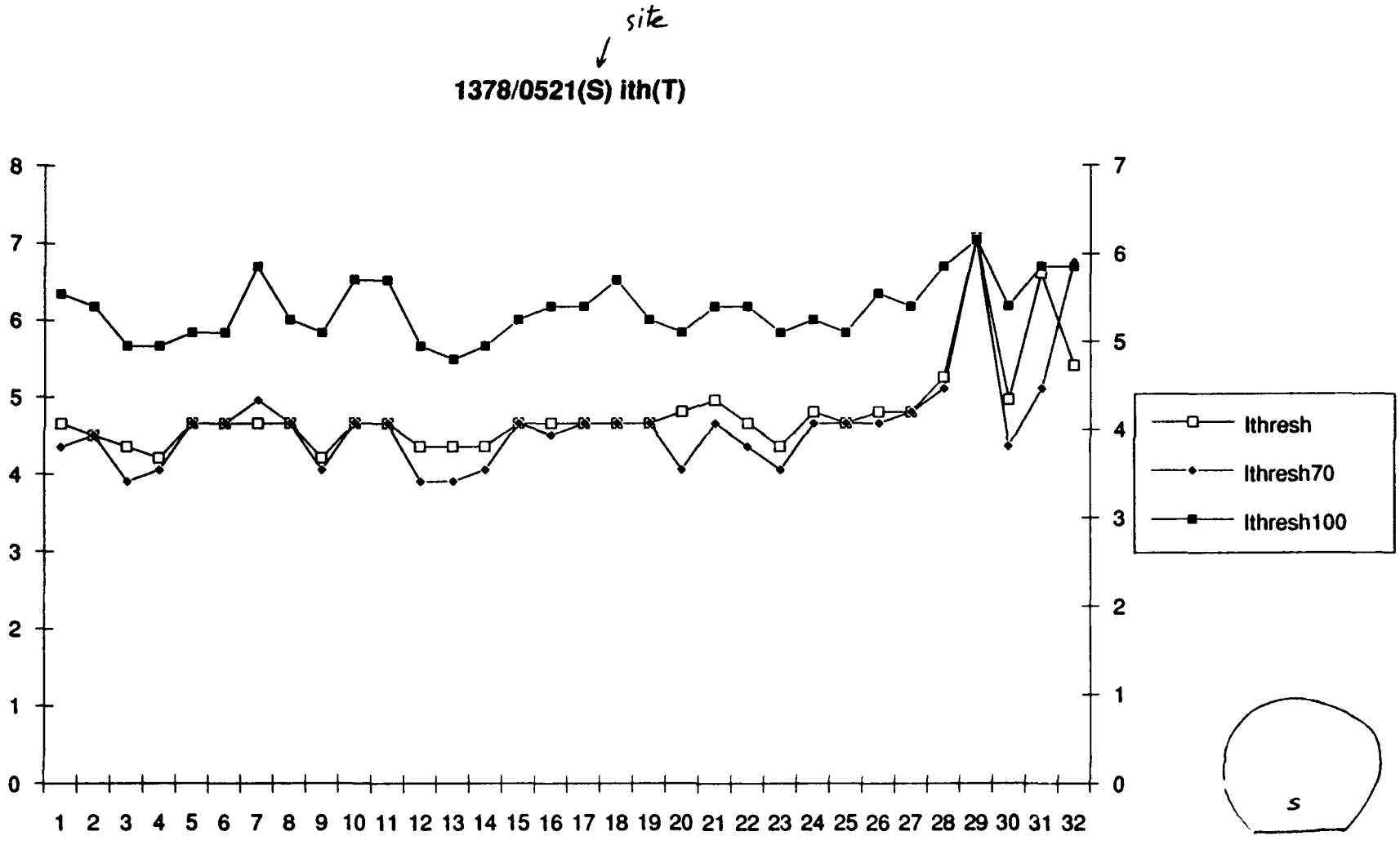

 Figure 1